

Article (cont. from p. 705)

never radiates, but it is more like a light seen through a piece of ground glass. When the auroras are intensified, the size of the auroral glory becomes variable: then double or multiple arcs with a common center are formed. Quite seldom, crossing arcs may be seen."

Nordenskiöld's drawing of this auroral circle, which is reproduced in Figure 3 of *Nygrén and Silén* (1982), shows a very regular zone centered somewhere in the northern part of Greenland and surrounding the polar region.

As Nordenskiöld used Mjølner's method to derive the height of the auroral arcs, it was important for him to find the center of the circle. His reasoning when searching for this center then was as follows [Nordenskiöld, 1880-1881]: "But because of the relationship which has been known to exist between the northern light and the magnetism ever since the days of Celsius and Hörter, and especially because of the fact that the crescent of the auroral arcs always and everywhere is situated close to the magnetic meridian, it is clear that one has to search for the center of the auroral glory in the neighborhood of the magnetic pole."

To determine this auroral pole more exactly, he took advantage of the theory of Gauss, and according to this the geomagnetic pole was located at 73°21'N latitude and 93°56'W longitude [Erman and Petersen, 1874].

From this short summary of Nordenskiöld's work it is quite evident that he had a conception of an auroral ring being very similar to the auroral oval introduced to geophysics in the 1960's [Feldstein, 1963, 1964], and almost identical to the circular zone derived by Holmström and Meng (1975) for the instantaneous distribution of the auroral arc in the polar ring.

Almost contemporary to the work of Nordenskiöld (1880-1881) was the work of Tromholt (1885). Tromholt also discussed the auroral ring and made an illustration (Figure 3), which clearly demonstrates why this ring often was called the "auroral glory." He also pointed out that this ring could have north or south and that this motion in some respect was related in variations in the solar sunspot cycle and the geomagnetic activity, an idea he had obtained from the work by Weyprecht, the great inspirator of the First International Polar Year [e.g., Tromholt, 1885]. Tromholt also, however, indicated that individual auroral forms could be parts of different rings centered at slightly different points along the geomagnetic axis [Tromholt, 1885].

Birkeland Demonstrated the Auroral Ring

To demonstrate his auroral theories, Birkeland (1901, 1913) produced by his famous terrella experiment luminous bands around the poles of a magnetized sphere suspended in a vacuum chamber in the laboratory (Figure 4). These bands when scaled properly resembled Birkeland in their behavior and structure very much of the naturally occurring auroral forms. He also showed that the position of the luminous ring, which he called the polar ring, changed by varying the magnetization of the terrella or by moving the magnetic pole with respect to the direction of the stream of cathode rays used to produce the luminosity. Based on the analogy with the natural situation, he then maintained that since the earth's rotation axis and the magnetic axis of the globe are not aligned, the earth would rotate underneath the polar ring in the course of a day, and the relative position

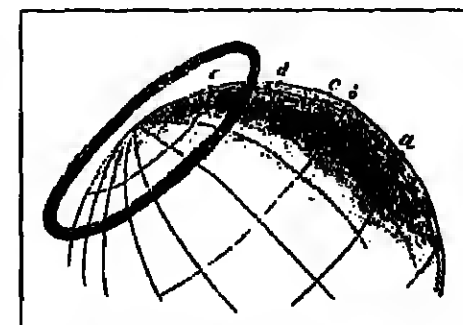


Fig. 3. The auroral ring or auroral glory as illustrated by Tromholt (1885).

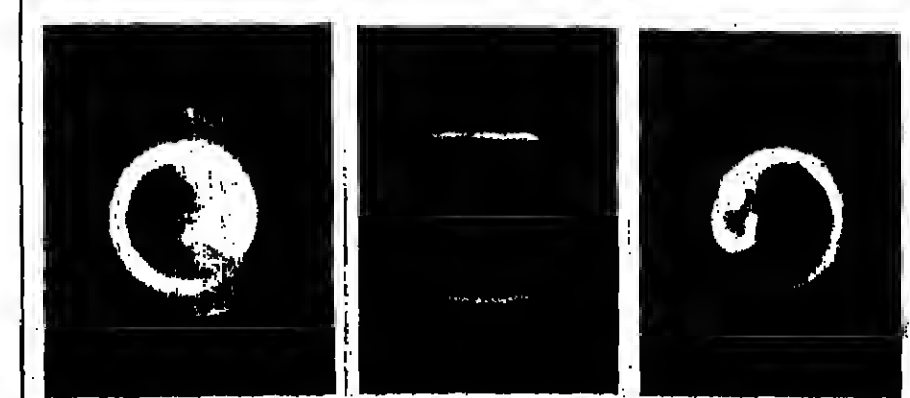


Fig. 4. A picture of some of the many polar rings as produced by Birkeland (1913) with his terrella experiment.

tion between the polar ring and an observing site would change accordingly.

Furthermore, he also demonstrated that the size of the polar ring would vary with the intensity of the discharge current producing the cathode rays and thereby made it probable that the polar ring in the natural case would react according to the outside geomagnetic disturbance. Any better experimental evidence for the existence of the auroral ring could hardly be presented at the beginning of this century.

Discussion and Comments

It should, from the preceding, be rather well documented that scientists in the middle of the 18th century had a fairly precise conception of the auroral arcs forming an instantaneous continuous luminous ring encircling the polar cap in the sky. Furthermore, it has been shown that this idea was elaborated on throughout the 19th century and that the auroral ring notion was a widely accepted interpretation of individual auroral observations.

Who should become the originator of the auroral ring conception is, however, difficult to settle; certainly it is neither Gerhild-Gyldenlöf as proposed by Alfven (1967) nor Nordenskiöld or Tromholt as proposed by Nygrén and Silén (1982). The idea has evolved through centuries, as often is the case in geophysical science, in a combination of speculation and intuition to be substantiated finally by modern observations and deductions.

This concept of the auroral ring seems to have disappeared from the consciousness of the auroral researchers with the beginning of the 19th century. The reason for this, obviously, must be sought in the success of the introduction of the auroral zone especially conducted by the works of Loomis (1866) and Fritz (1881). The auroral zone was indeed a plumb line of the prevailing spirit of the time, being dominated by collections of long data series and relatively simple statistical treatments of large data bases. Less importance was attached to the event studies that had dominated the Scandinavian school for more than 150 years. One can understand the different ways in attacking the problems of auroral research among Scandinavians and other Europeans. The Scandinavians were actually observing the phenomena from event to event, while the other Europeans were forced to study it from annals and reports handed over in them by others. For the Scandinavians, therefore, it was more natural to seek a physical understanding of auroral events rather than to describe morphologically the global and annual distribution of the phenomenon.

Of course, scientists outside Scandinavia had attained great success with their comprehensive statistical analysis in establishing the solar cycle and the secular geomagnetic variations, an analysis method that also later became a decisive factor in the manifestation of the dynamo theory. The aurora was in these days largely discussed as an optical phenomenon and, as such, as belonging to the earth's atmosphere. An auroral zone, therefore, in many ways reminded people of the climatic zones and brought the aurora into a frame of reference that satisfied the common sense. This analogy to the climatic zones, however, was based on a rather vague understanding of the fundamental cause of the aurora and overlooked the most predominant properties of the phenomenon; namely, its very irregular behavior and variability.

In hindsight, the auroral scientists had an excellent chance to confirm the concept of the auroral ring by analyzing simultaneous auroral observations obtained at the many polar stations operating during the First International Polar Year (1882-1883). Instead of accomplishing a coordinative analysis of the different data sets, however, the scientists wrote monumental national reports of their achievements in the polar region. This unique chance brought to the scene of science by the ingenious idea of Weyprecht was frittered away by national prestige and professional pride. One of the few ever to use auroral data from the First International Polar Year for case studies was Birkeland (Birkeland, 1901). From these analyses he basically substantiated his theory of the horizontal auroral current in the upper atmosphere being part of a large current loop closing into space along the magnetic lines force. His work was set aside by defenders of statistical analysis of

Forum

Dynamics

"Dynamical" she said, as she buried her head deep in a book on tectonics.

"Must be the key to explain what we see the ignorance of which seems to be chronic."

Convection below, then intensity flow and phase changes are not withstanding; Thermal gradient change and compositional range are things our minds should be commanding.

With knowledge like this, we could easily kiss off outrageous, absurd speculations. On the causes of motions that open the oceans that lead us to wrong cogitations.

The continents move! This has been proved, kinematics in detail has been studied; But the structural state of each moving plate leaves the waters less clear and more muddled.

Readers are coddled by successive models that ignore basic physical laws. The authors expound, but no proof can be found that they've done more than just wave their claws.

If it's mechanically "go," then why can't they show by making some astute assumptions That the heat is enough or the surface too rough to cause oceanic conceptions.

I agree with the fact, on the mandle we lack specifics; but we can at least try. For a sensible stance, a physico-chemical glance at the models before we throw pigs.

We don't know the score, in the mantle or core cry so many, but let us give pause. Regardless of likes; Isacks, Oliver and Sykes; Treatment's not through the symptoms, but cause!

Barbara Ransoni
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Berkeley, Calif.

This was written during the author's first course in plate tectonics and may sum up one's first exposure to literature.

enormous collections of magnetometer recordings and completely forgotten for several decades. In a sense, the fate of the auroral ring concept and Birkeland's theory have some similarities. They both represented two very promising ways of attacking important physical problems in auroral research, and they were both based on relatively sound physical insight into these phenomena; however, they both were dispelled from the scientific scene for many decades and called to mind again in the 1960's.

There is little doubt that in auroral research the idea of an auroral zone was a dead end and that the auroral ring or circle was a far more realistic concept in understanding the auroral distribution. The physical advantage of the auroral ring or belt, as Feldstein (1967) called it, was also pointed out by him in the following way: "The auroral belt has thus a more definite physical sense, as it indicates an exact location of the phenomenon under consideration."

That the old idea of an auroral ring was very much on the right track may be best demonstrated when comparing the illustration of the auroral ring made by Nordenskiöld in 1880-1881 (see Figure 3 of Nygrén and Silén (1982)) with the more up to date illustration of the auroral oval made by Holmström and Meng in 1975. Holmström and Meng (1975) pointed out that the inner and outer contours of the auroral oval as observed by optical cameras in satellites would be well fitted to circles with their centers slightly displaced from the corrected geomagnetic pole and that these centers moved slightly and the radii of the rings increased when the geomagnetic activity increased. This conclusion is indeed very similar to the descriptions of Tromholt (1885) made 90 years earlier.

Conclusion

We have during the last few years seen a growing interest for historical work in the field of geophysics and especially within auroral physics [Brekke and Egeland, 1979, 1983; Eather, 1980]. To make these historical reviews complete and to be sure that one has exerted justice to every past or present scientist is, of course, insurmountable and is not the main purpose of these efforts. If, however, we from such historical reviews can learn to respect the work of the predecessors on our field in the light of the much less developed scientific milieu they were working in, we hope that the future can avoid entering traveling such an impassable road as the auroral zone and losing decades of progressive thoughts.

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Cover. The system shown in the photograph is a digital heat flow instrument package used by K. E. Louden of the Department of Oceanography at Dalhousie University. This system allows for in situ measurement of geothermal gradients and the weight stand at the top of the picture houses two pressure vessels containing the electronics. A microprocessor controls the measurement, recording, and telemetry of the temperature data. A 12-KHz pinger transmits the temperature data to the surface for a real-time representation of the process. The 4-m-long sensor string encased in an oil-filled 5/16-inch stainless steel tube runs along the strength member on the left-hand side. The sensor string consists of nine equally spaced thermistors and a heater wire. The violin bow-style attachment of the string is to reduce the effective thermal disturbance by the penetration of the strength member into the sediments. This package is designed for multiple penetration probing, where the probe is poked along the bottom, allowing for up to 20 stations per lowering. The electronics were designed and built for Dalhousie by Bullard Laboratories at Cambridge, U.K. (This photo was contributed by D. Hebert, Department of Oceanography, Dalhousie University, Halifax, NS B3H 4J1 Canada.)

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News

Satellite Congestion

At last count, there were more than 160 satellites in geostationary orbit, circling the earth at an altitude of 37,000 km, according to a research review published recently by the Rand Corporation, that's already too crowded. The risk of physical collisions among satellites is small, say authors Alvin L. Hiebert and William Solfray, but there is an emerging problem with what they call "spectral and orbital congestion," the result of too many satellites and ground stations sending out too many electromagnetic signals that can interfere with one another.

The report comes at a time when the Federal Communications Commission is planning to reduce the spacing between satellites along the U.S. segment of the orbital arc so that 37 additional satellites can be squeezed into the high orbit favored for telecommunications. "As more satellites are launched and others are shifted to avoid collisions, interference problems will get more complicated," say the authors of the report.

The problem of satellite transmission interference is analogous to the effect of passing a radio broadcast tower while driving in your car. Even though your receiver is tuned to another frequency, the nearby transmitter can interfere with your signal. For commercial telecommunications satellites constantly circling the earth and drifting around within their prescribed orbits, signal interference is a nuisance. For military data satellites, it could be a danger. And proximity is not the only possible source of interference. A satellite ur ground station can even interfere with itself if a malfunction in its electronics causes a signal to travel from one spacecraft component to another.

Fortunately, someone has been trying to solve, or at least to get an analytical handle on the problem. In the past several years engineers working in the private sector, the government, and the military have developed more than 20 different computer programs designed to solve problems of "electromagnetic compatibility," and the main purpose of the Rand authors was to list and describe all these "Techniques for the Analysis of Spectral and Orbital Congestion in Space Systems," which is, incidentally, the title of their report. These specialized computer programs are designed to help groups planning to launch satellites by telling them what kinds of interference problems they can reasonably expect to encounter in geosynchronous orbit. Hiebert and Solfray's report also deals with the vulnerability of satellites to various kinds of manmade and natural interferences from deliberate jamming efforts to the blunders that could be caused by nuclear explosions in space.

As a result of the Rand report, the Air Force Space Division has formed several offices to make use of the techniques for analyzing the effects of orbital crowding, and is using the information to prepare for the World Administrative Radio Conference in 1985. Sponsored by the International Telecommunications Union, an agency of the United Nations that allocates worldwide radio frequencies, this conference will be a comprehensive discussion of geostationary orbital positions and other space communications issues. In addition, the Department of Defense has begun compiling a data base on space and earth electromagnetic environments at its Electromagnetic Compatibility Analysis Center (ECAC) in Annapolis, Md., in the hope that computerized analytical tools might help to alleviate the problems of satellite congestion.

Award Honors Duggal

Shakti P. Duggal, a widely respected member of the international cosmic ray community, was a member of the scientific staff of the Bartol Research Foundation for 22 years prior to his untimely death in 1982 at the age of 50. In his memory an award has been established by his colleagues and friends to honor outstanding work by a young scientist in the field of cosmic ray physics. The first biennial award, consisting of \$1,000 and a plaque, will be presented at the 19th International Cosmic Ray Conference (ICRC), to be held in La Jolla, Calif., August 10-24, 1985.

The intent of this award is to inspire young cosmic ray scientists at an early stage of their careers. The recipient will not have attained the age of 36 on January 1 of the year of the ICRC at which the award will be presented. Subject to this limitation, any person from anywhere in the world who has contributed to the field of cosmic ray physics is eligible for consideration. Selection of the prize winner will be made by an international committee consisting of John Simpson, University of Chicago; Peter Fowler, University of Bristol; Michelle Case, Center for Nuclear Studies, Saclay, France; Arnold Wolfendale, University of Durham; and Martin Pomerantz, Bartol

Research Foundation, University of Delaware.

Nominations of potential recipients are now being solicited. Nominators are requested to send to the committee secretariat at the Bartol Research Foundation their nominee's vita and publication list, a supporting letter, and, if possible, copies of one or two of the candidate's most significant publications. The sponsor may also wish to ask one or two sponsors to send letters supporting the nomination to the secretariat.

Nominations, which should reach the secretariat before December 15, 1984, may be addressed as follows: Duggal Award Committee, Bartol Research Foundation of the Franklin Institute, University of Delaware, Newark, DE 19716.

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Dissertations with order numbers, and many of the others listed, are available from University Microfilms International, Dissertation Copies, P.O. Box 1764, Ann Arbor, MI 48106.

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Apparent Polar Wander Paths for the North and South China Blocks, J. Lin, Dept. of Geol. Sci., Univ. of Calif., Santa Barbara, Spring 1984.

Aquatic Geochemistry of the Particle-Remotive Radionuclides B-7, Po-210, and Pb-210, J. F. Todd, Dept. of Oceanogr., Old Dominion Univ., Mar 1984.

Geology and Paleogeography of the Diphlogitum (Grapholite), C. E. Murrell, Dept. of Geol. Sci., Harvard Univ. (S. J. Gould), November 1983.

Characterization and Stability of Phase A, A Hydrous Pressure-Dependent Phase in the System MgO-SiO₂-H₂O, A. I. Benimoff, Dept. of Appl. Sci., Coll. of Staten Isl. (C. S. Sclar), October 1984.

Depositional Modeling of Tetrahedrite in the Coeur d'Alene District, Idaho, C. J. Hackbath, Dept. of Geol. Sci., Harvard Univ. (U. Petersen), June 1984.

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Books

Iron-Formations: Facts and Problems

A. F. Trendall and R. G. Morris (Eds.), *Dev. in Precambrian Geol.*, vol. 6, Elsevier, New York, xiv + 558 pp., 1983, 106.00.

Reviewed by Henry Lepp

This book is similar in format to *Precambrian Iron-Formations of the World*, published in 1973 as a special issue of *Economic Geology* (vol. 68, no. 7). Both have 16 papers and begin with descriptions of iron formations or iron districts followed by topical papers on various aspects of the iron formation problem. New basic data on Precambrian iron-bearing and associated rocks has continued to accumulate since 1973, and the present volume admirably fills the need to compile this widespread information and to reexamine these enigmatic rocks in the light of new discoveries.

Iron Formations: Facts and Problems is almost twice as long as its predecessor. Moreover, the descriptive section (80% of the book) is limited to five large iron districts, which provides space for exceptionally thorough syntheses. The introduction by Alex Trendall clarifies the purpose and scope of the book and presents a thoughtful review of problems associated with the nomenclature and classification of Precambrian iron-bearing rocks. A. B. Alenky begins the descriptive section with a detailed analysis of the Ausimite Basin including its regional setting, geochronology, and paleogeography. A. F. Trendall updates and summarizes the extensive work that he and others have done in the Hamersley Basin, and A. D. T. Goudie, W. D. M. Hall, and J. A. Dunne describe the geology, structure, and iron formations of the adjoining Naburn Basin. The paleoenvironmental settings of iron formations in the Transvaal-Graptolite West districts are also covered by N. J. Beukes, G. A. Criss and I. S. Zapp present a thorough review of the geology, iron formations, and depositional environments in basins marginal to the Ungava craton including the Labrador Trough.

Nine contributors are typical. R. Davy's review of chemical compositions of iron formations is heavily based on Hamersley analyses. The rather scanty data on rare earth elements in iron sediments are summarized and interpreted by B. J. Fryer. E. C. Perry adds considerable new information on oxygen isotopes and discusses problems in data interpretation. M. R. Walter and H. J. Hofmann survey the paleontology of Precambrian iron sediments and conclude that neither stromatolites nor convincing evidence for microfossils are known for Archean iron formations. Preston Cloud reviews and modifies his model for the genesis of banded iron formations. A lengthy and detailed contribution by G. Klein looks at the diagenesis and metamorphism of iron formations in the light of new chemical and mineralogical data. H. L. James after bravely assessing the ages and ionages of major iron formations offers explanations for their distribution in time and space. W. E. Evers' paper on chemical factors in deposition and diagenesis focuses on the Dales Gorge Member of the Brockman Iron Formation. Like other authors, Evers "would have wished to have transferred more of this topic from areas of opinion and controversy into areas of reasonable certainty." A comprehensive analysis of the supergene alteration of banded iron formations by R. C. Morris ends the volume.

A short paper by Heinrich Holland in the 1973 work titled "The Oceans: A Possible Source of Iron in Iron-Formations" appears to have had a marked effect on the present volume. As was noted by Harold James in the forward, almost all contributors have accepted the idea of an ocean reservoir for the iron and silica. How the iron, silica, and other constituents were precipitated from this reservoir is another matter. Explanations are lightly subjective and focus chiefly on possible mechanisms for the precipitation of banded cherty oxide iron formations. Of course, all iron formations are not banded, nor do all contain oxides as the principal or primary iron minerals. Although chert is the main non-iron component, since iron formations contain significant quantities of carbonate gangue. In spite of their textural and mineralogical variability, most iron formations consist of approximately equal parts of iron and non-iron minerals. How actual units of such dissimilar elements were laid down in what appear to be diverse environments remains a major puzzle. Although this book does not have all the answers, its excellent coverage of new geologic, chemical, paleontologic, and mineralogical data should be most useful in stimulating further research.

Authors of the descriptive chapters were asked not to focus on the iron formations but to show how these rocks related to the development of the various depositional basins. Their contributions on six widespread and well-preserved segments of early crust thus represent significant contributions to Precambrian geology.

The printing and illustrations are generally of high quality, and there are very few errors. Chapter references are extensive, and the index is most useful. This book should be in the libraries of all geologists interested in the Precambrian, but the high cost may impede its wide distribution.

Henry Lepp is with the Geology Department, Macalester College, 1600 Grand Ave., St. Paul, Minn.

Drinking Water Supplies: Protection Through Watershed Management

Raymond J. Burby, Edward J. Kaiser, Todd L. Miller, and David H. Morean, Ann Arbor Science, Ann Arbor, Michigan, 1983, xiii + 275 pp., \$59.95.

Reviewed by G. William Page

The practice of purchasing land to protect surface water supply sources is rarely practical today. This is particularly true near urban areas. Therefore, *Drinking Water Supplies* attempts to provide an action-oriented guidebook on how to develop and implement watershed management strategies to protect surface water supplies from contamination under the constraints of today's economic, legal, institutional, and political conditions. The book succeeds in providing a very clear and useful guide to the process of developing such a strategy. It should be helpful in small and moderate-sized water supply systems and local governments interested in taking action to protect their surface water supply sources.

Most of the book is devoted to process. That is, it is a detailed checklist of the factors that must be considered, the studies that must be completed, and the steps that must be taken. This is a substantial contribution to the literature. While there are many works that touch on protecting water supply sources, they are generally either very broad in focus or they are more technical and more narrowly focused. Some examples of locally focused works are Dunne and Leopold, *Water in Environmental Planning and Geomorphology*; *Principles of Water Resources Planning*. Examples of national but more technical and narrowly focused works include Milliken and Taylor, *Metropolitan Water Management*; Pojauskis, *Drinking Water Quality Enhancement*; *Tough Source Protection*; Greenberg and Hordson, *Water Supply Planning*; and Whipple, *Urbanization and Water Quality Control*. All of

these references are good and useful to the task of protecting water resources, but *Drinking Water Supplies* provides the most comprehensive and clearly elaborated approach to developing, implementing, evaluating, and updating an effective multidimensional strategy.

My major criticisms of *Drinking Water Supplies* concern issues of omission. The group for whom this book will have the greatest use are water supply system and local government officials charged with providing potable water to small or moderate-size municipalities in the United States. More than half of the small and moderate-size municipalities rely on groundwater for their source of water, and this book does not address protecting groundwater sources. While many of the land use planning methods designed to protect watersheds are also useful in protecting aquifer recharge areas, this book does not describe differences in groundwater and surface water systems, nor does it attempt to suggest differences in strategies to protect these different sources of water. A volume addressing this issue would be a welcome companion to the book under review. My second disappointment with the book is the lack of attention to the special problems of protecting water sources from contamination by toxic substances. The authors discuss this problem, but seem to assume that measures to protect watersheds from conventional pollutants will be sufficient to protect watersheds from pesticides, heavy metals, industrial solvents, and other toxic chemicals. Because of the danger to public health caused by extremely low concentrations of these substances, this issue demands much greater attention in developing watershed management plans.

Of particular interest in *Drinking Water Supplies* are the results of a survey of present watershed management practices and the lists of techniques which can potentially be included in a comprehensive strategy to protect water sources. The results of the national survey of surface water systems which excluded both very large and very small systems provide interesting reading, especially lists of the problems perceived to be the most serious and the techniques thought to be the most effective. The discussion of potential approaches and techniques is comprehensive and very useful. In general the book provides ample references to additional and more detailed sources of information.

G. William Page is with the Department of Urban Planning and the Center for Great Lakes Studies, University of Wisconsin-Milwaukee, Milwaukee, WI 53201.

Crystal Symmetry: Theory of Colour Crystallography

M. A. Jaswon and M. A. Rase, Ellis Horwood Ltd., Chichester, England, 199 pp., 1983.

Reviewed by Charles W. Burnham

Geophysicists concerned with physical properties of crystalline solids might to have a working familiarity with space group symmetries, especially as the symmetries of atomic arrangements affect the directional behavior of these properties. While an understanding of the operational characteristics of the 230 three-dimensional space groups will suffice for most applications, magnetic properties can reflect more complex symmetries that hinge not only on atomic position but on orientation of magnetic moment as well. With "spin" variability included, the total symmetry can fall into any one of 1101 magnetic—or color, black and white, or Shubnikov—space groups distributed among 58 magnetic point groups.

Although this book emphasizes color crystallography in its title, it includes an exposition of the underlying noncolor crystallography, assuming no prior crystallographic knowledge. Its 14 chapters are divided into three parts: part 1 with four chapters on crystallographic point groups; part 2 with four chapters on space lattices; and part 3 with six chapters on space groups. Only the last chapter of each part enumerates the groups containing color operations. There are nine short appendices, some of which contain important basic material that the novice to this subject will need to master early on. The text might be classified as an annotated compilation of all the various symmetry groups: rigorous derivations are scant, and applications, examples, and problems are occasionally absent. The approach is primarily group theoretical with a smattering of matrix representations and linear algebra and a few geometric representations that provide some visual reinforcement. The text is generally terse and in some cases not well organized. For example, the first encounter with the important X operator is in Table 1.2, whereas it is not discussed in the text until the end of chapter 2, yet some other notations appear in chapter 1.

Of particular interest in *Drinking Water Supplies* are the results of a survey of present watershed management practices and the lists of techniques which can potentially be included in a comprehensive strategy to protect water sources. The results of the national survey of surface water systems which excluded both very large and very small systems provide interesting reading, especially lists of the problems perceived to be the most serious and the techniques thought to be the most effective. The discussion of potential approaches and techniques is comprehensive and very useful. In general the book provides ample references to additional and more detailed sources of information.

G. William Page is with the Department of Urban Planning and the Center for Great Lakes Studies, University of Wisconsin-Milwaukee, Milwaukee, WI 53201.

unaware that a crystal whose lattice has a square prismatic unit cell, for example, is not tetragonal unless it can be demonstrated that its atomic arrangement possesses fourfold symmetry in one direction; the lattice itself is not inconsistent with any lesser symmetry.

The geophysicist concerned with the implications that symmetry has for atomic structure and therefore on physical properties will not find this book helpful. The problem of determining symmetry is not considered at all. I can recommend this book only to those scientists already well conversant with space groups who would like to see an efficient, somewhat elegant, primary group theoretical enumeration of all crystallographic color point groups, translation groups, and space groups.

Charles W. Burnham is with the Department of Geological Sciences, Harvard University, Cambridge, Mass.

The Exploration of Outer Space With Cameras

M. M. Mirabito, McFarland, Jefferson, N. G., 1983, vi + 170 pp.

Reviewed by Michael J. S. Bellon

This monograph "chronicles the use of television cameras and other visual imaging systems by NASA on unmanned outer space probes and in the exploration of the Solar System's planetary bodies."

The book is technically well organized and a nicely printed volume with the unfortunate exception of the 32 illustrative plates that are of nothing less than abysmal quality. Included in the selection of pictures are a number of classic Voyager color photographs, but the high contrast black and white renditions in this volume convey little of their original beauty or information content.

The contents are organized into 11 chapters that cover, with detailed descriptive material, imaging systems on NASA spacecraft starting with the Ranger moon probes through Voyager (chapters 1-6). There is a very brief discussion of the need for calibration and image processing (chapter 7); another brief (chapter 8) and, in my view, superficial exposition on what subsequent scientific analysis of the returned images has yielded: a chapter on proposed missions; and a brief chapter on spin-off from these NASA projects to applications in medicine, astronomy, and the communications industry. The last chapter—only one page long—on Implications and Conclusions best illustrates, I think, the weakness of the book: The author seems to have great difficulty in expressing his excitement with the subject to any great depth or intellectual conviction. His conclusion that "the next step is manned flight to these worlds" springs out of nowhere and, although this reviewer expects that this might be a popular conclusion with many of the readers for whom the book was designed, it does not seem to connect in any logical way to the subject matter.

The book has an extensive section (31 pages) of chapter notes, references, and a good bibliography. The latter includes a wide range of material, from congressional subcommittee minutes to major journal articles, that is useful in itself. Apart from its brevity, which sometimes leaves one with an impression of superficiality, there are also some real problems with the text. For example, the author occasionally makes analogies with simpler phenomena in everyday experience in order to clarify a difficult point. But this rarely seems to work. In one case, an attempt to explain the origin of ringlets in Saturn's ring system, he uses an analogy based on the behavior of hanging iron filings on the bottom of a flat disk. The result is nothing less than a total obfuscation. This reviewer will stick to Goldreich and Tremaine.

What this reviewer missed most, while reading this "chronicle" of great human achievements, was any identification of the camera systems and projects with the real, individual, people who were involved. Who were the engineers and scientist that put the cameras, design criteria, sequences, etc., together? Who set the priorities? Who made the discoveries? What were their disappointments and tragedies? History without people is surely dull. The book is recommended only to those who have a peripheral, nontechnical, interest in the subject matter.

Michael J. S. Bellon is with the Kitt Peak Observatory, Tucson, Ariz.

Geological Evolution of the Earth During the Precambrian

L. J. Salop (trans. by V. P. Grudina), Springer-Verlag, New York, 489 pp., 1983, \$65.80.

Reviewed by Edward S. Grew

Salop's book is a review of geologic history during the Precambrian, with an emphasis on subdivision of Precambrian time, worldwide comparison of stratigraphic sequences, and characterization of tectonic regimes. The author cautions in the Preface that the book is not "a compilation; the problems discussed

here are those with which the author was concerned personally." Nonetheless, the book is an ambitious synthesis of nearly 3500 million years (my) of earth's history. Salop proposes a division of the Precambrian into 5 eras (time span before present in my): Katarchean (≈ 3500), Palaeoproterozoic (3500–2600), Mesoproterozoic (2600–1900), Neoproterozoic (1900–1000), and Epiproterozoic (1000–850). The sub-era Eocambrian (650–570) is provisionally included in the Palaeozoic Era. Each era is characterized by distinctive lithostratigraphic cycles of global extent. After an introductory chapter in which the principles of the division are discussed, Salop devotes a chapter to each era and to the Eocambrian and concludes in the eighth chapter with a synthesis. Chapters 2–7 consist of two parts: "Rock Records" and "Geologic Interpretation of Rock Records." The first part is largely a description of the lithostratigraphic complexes, including correlation of stratigraphic columns, from most of the world's Precambrian complexes. The second part discusses the physical and chemical environment on the earth's surface during the era covered by the physical and chemical environment, life, tectonic regime, principal stages of geologic evolution, and other topics appropriate to a particular era. While Salop devotes more attention to Precambrian terranes exposed in the Soviet Union, he covers in considerable detail all the world's Precambrian rocks for which sufficient information is available. Consequently, the reader will find in this book a wealth of factual material. Salop is to be commended for pulling together and distilling a large amount of information from a vast literature (24 pages of references, although only a handful more recent than 1980).

Perhaps more important for many readers, however, is the exposition of a different perspective on Precambrian rocks. Salop's division of the Precambrian is based on his view of the Precambrian as a succession of cycles that "happens against the background of a directed and irreversible evolution of the earth." (p. 379). Each large geologic cycle ("megacycle"), represented by an era, includes a distinctive sedimentary environment (e.g., glacial deposits in the Epiproterozoic) and tectonic regime (e.g., mantled gneiss domes

in the Palaeoproterozoic). These cycles, like the orogenic cycles, are also worldwide in scope and appear in all exposed Precambrian terranes of appropriate age. As a consequence of this view, the fundamental criteria for correlating Precambrian units are lithological, with metamorphic features. In addition, Salop makes use of radiometric ages (surprisingly, the Sm-Nd isotope method is not mentioned) in correlating Precambrian events, particularly in timing the important orogenic cycles. However, isotopic ages are in most cases a secondary consideration. In the case of the Isua Supracrustals of West Greenland, Salop acknowledges that the radiometric dates near 3800 my are convincing evidence for a Katarchean age of the Isua rocks and that these dates override lithologic and metamorphic considerations, notably presence of conglomerates and greenschist to amphibolite-facies metamorphism, which are indicative of a Palaeoproterozoic age. For the general case, however, granulite-facies metamorphism, in part retrograded under amphibolite-facies conditions, and accompanied by metasedimentary or anatectic enderbitis and charnockites, are characteristic of Katarchean rocks and with rare exceptions, confined to this era. Thus, North American geologists will be surprised to see the granulite-facies Grenville Group included in the Katarchean because of this group's metamorphic grade and lithologic similarity to Katarchean marble and calc-silicate-bearing units in the Aldan Shield and Lake Baikal areas of Siberia. Salop attributes the Grenville ages near 1000 my to intense thermal-tectonic reworking of a preexisting granulite-facies complex. Students of Precambrian geology may not share Salop's scepticism regarding the usefulness of isotopic data in determining ages of sedimentation, volcanism, and of the original (hence, most important, in Salop's view) metamorphism. On the other hand, Salop's interpretation that most high-grade rocks are old and have undergone repeated metamorphic and deformational events has considerable validity. "Isotopic rejuvenation," Salop's expression for disturbances in isotopic systems by later events, is characteristic of Precambrian high-grade metamorphic rocks, even of the Sm-Nd system in some cases. In this reviewer's experi-

ence, isotopic rejuvenation has hindered attempts to determine the crust formation and original metamorphic ages of many amphibolite- and granulite-facies rocks in the Precambrian shield of east Antarctica.

Other interpretations forwarded by Salop, however, do not appear as firmly based in theory and observation as his outlook on isotopic ages. For example, Salop argues that plate tectonics is not applicable to the Precambrian (except, possibly in the "late Precambrian," p. 407, here unspecified). As an alternative explanation for the origin of the ocean basins, he supports the suggestion that these formed by "subsidence of the lower part of the crust into the upper mantle" (p. 402) in conjunction with limited expansion of the earth. Moreover, this reviewer finds that Salop's terminology for the eras is cumbersome and confusing, particularly the term "Proterozoic," which sounds almost like "Proterozoic." His rigid classification scheme does not allow for either widely different evolutionary in different parts of the world, non-synchronous orogenic events and sedimentological environments, or for repetition of certain phenomena, such as granulite-facies metamorphism in post-Katarchean time.

By and large, V. P. Grudina's translation from the Russian has produced a readable English text. However, a few odd words and phrases have escaped the editors, for example, "sensitivity" for "sensitivity" (p. 70), "submergence of minor fold bends" (p. 40), and "general unregulated situation" (p. 68). An occasional passage is incomprehensible. Typographical and spelling errors occur about once every five pages. Reproduction of the figures (all but one are line drawings) is good. However, the larger-scale maps are without geographic coordinates and an index map, so that the reader is at a loss to locate these maps in their larger context.

In sum, the Precambrian specialist would be well advised to add Salop's book to his reference library, but the more general geologist may find the price a bit high for an alternative view of Precambrian geology.

Edward S. Grew is a Humboldt-Stipendiat at the Ruhr-Universität Bochum, Institut für Mineralogie, Postfach 10 21 48, D-4630 Bochum 1, West Germany.

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Send enquiries and applications to Dr. Albert B. Bally, Chairman, Department of Geology, Rice University, Houston, Texas, 77251-1892. Applications should include a detailed resume, the names and addresses of three references, and a statement of research interest.
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Cooperative Institute for Climate Studies/Announcement of Postdoctoral Fellowship. The Department of Meteorology at the University of Maryland, College Park has established the Cooperative Institute for Climate Studies (CICS) with NOAA. The Institute is involved in a variety of studies oriented toward a better understanding of climate and currently has an opening for a postdoctoral fellow to join the current Institute staff in the area of steady state climate modeling. This position calls for a meteorologist with experience or interest in experiments with steady state climate models. Principal activities will involve running experiments with existing steady state models, deriving careful verification procedures, handling extensive observed data sets, making modifications in model physics and forcing, and devising more efficient computational schemes for running the models.
Letters of application should be sent to F. Bass, Director, CICS, Department of Meteorology, University of Maryland, College Park, MD 20742. Applications should include a curriculum vitae and names of three references. Applications received before October 15, 1984 will receive full consideration.

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Francis G. Stehlé, Dean
College of Geosciences
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Consideration of applications will begin January 1, 1985.
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Advances in Geodesy

Edited by Erik W. Grafarend and Richard H. Rapp

\$23

From papers previously published in AGU's prestigious journal, *Reviews of Geophysics and Space Physics*, this volume is a collection of 30 papers which are sharply focused on recent advances in solving geodetic problems. The papers are divided into four sections: Geodetic Theory, Geodetic Estimation Procedures, Gravity Field, and Applications.

ADVANCES IN GEODESY, a thoughtful examination of recent geodetic developments, is required reading for those with either central or peripheral interests in geodesy.

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Letters of application should be accompanied by a resume that includes a description of research interests and accomplishments and teaching experience, a list of publications, and the names of at least three references. Send to: S.O. Schlinger, Chairman, Department of Geological Sciences, Northwestern University, Evanston, Illinois 60201. Closing date for applications is November 1st, 1984. We expect to fill the position for the fall of 1985.

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Faculty members are expected to conduct a visible and active research program, teach graduate and undergraduate students, and supervise theses. Inquiries and letters of application should be sent to P. Geoffrey Keiss, Department of Geology 028A, University of North Carolina, Chapel Hill, NC 27514. Applications must include resume, statement of research and teaching interests, and names of at least three references. Closing date for applications is October 19, 1984.

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It is anticipated that the person chosen will devote the major part of his or her time to research activities. However, there is an opportunity for participation in academic responsibilities of Electrical Engineering Department, including when time permits, teaching graduate and undergraduate classes, serving on various committees of the department, School of Engineering, and the University. It is expected that the person chosen will participate actively in the training of graduate students.

The Chairman of the selection committee for this position is Professor Robert A. Hellwyl, Professor of Electrical Engineering, Space, Telecommunications, and Radiological Laboratory, Stanford University, Stanford, CA 94305. Other members of the selection committee include Professor P.M. Banks, Professor K.N. Brarwale, Professor L.R.O. Storey, and Professor L. Tyler.

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William Ellsworth
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Postdoctoral Research Position/Petrology/Geochemistry/Northern Illinois University. Department of Geology. Recent Ph.D. recipient is sought for one year position starting in early 1985. Strong analytical background in XRF or plasma spectroscopy is preferred. The Department of Geology is in the process of acquiring new, automated XRF and OC plasma spectrometers. The successful candidate will be involved in the development of sample preparation, analytical, and data-reduction procedures, as well as instruction of other users. Independent or collaborative research will be expected. The Department also has solid- and gas-source mass spectrometers, automated EMP, and excellent computing facilities. Please send application, resume, and the names of three references to J.H. Berg, Department of Geology, Northern Illinois University, DeKalb, IL 60115. Application deadline is October 15, 1984.

Northern Illinois University is an affirmative action/equal opportunity employer.

American Museum of Natural History. The Department of Mineral Sciences is seeking to fill a tenure track position for Assistant Curator beginning July 1985. This is mainly a research position, but some time is needed for collections management and departmental activities. High quality sample oriented research and publication is the prime responsibility. The field of specialization is mineralogy, petrology, and may include and combine aspects of petrologic mineralogy, ore mineralogy, mineral geochemistry, crystal and thermochronometry, mineral physics, X-ray crystallography, ultrastructure analysis, crystal growth, spectroscopy or gemology. Major research facilities include a fully automated ARLENCO electron microprobe, X-ray laboratory, microcomputer, and vast mineral and other collections. The opportunity exists for research and/or teaching collaboration with nearby institutions or such as Columbia (Lamont-Doherty Geological Observatory).

Requirements are a Ph.D. in hand by the time of appointment and an ability to carry out a research program. It is expected that some research support will be sought outside the Museum. Applications should include: (1) a curriculum vitae, (2) names of three persons familiar with your work, and (3) a statement of research interests and specific projects to be carried out within the next five years.

These must be submitted by November 15, 1984 to:

Martin Prinz
Chairman, Search Committee
Department of Mineral Sciences
American Museum of Natural History
New York, NY 10024

An equal opportunity/affirmative action employer.

RESEARCH POSITIONS AVAILABLE

The Lunar and Planetary Institute is a center for Planetary and Earth Science research associated with NASA programs. The Institute presently has 2103 positions available at the postdoctoral and staff scientist levels. Appointments are initially for one year with the possibility of renewal for additional years.

Areas of current research interest at the Institute include: geophysical analysis of global data sets; planetary geology, including the analysis of surface images and theoretical and experimental studies of impact cratering; terrestrial remote sensing with special reference to volcanic phenomena; planetary tectonics, especially of Mars, Venus and the Earth; and the early crustal genesis of terrestrial planets.

Applications from specialists in all areas of planetary and earth science are invited and will be particularly welcome from researchers whose work suggests or complements existing programs.

LPI facilities include a computer center equipped with a VAX 11/780, an image processing facility equipped with a Gould/DeAnza IP 8500, a geophysical data facility with interactive graphics capability, extensive library holdings in the geosciences, and a major collection of space photography.

The LPI, funded by NASA through the Universities Space Research Association, is located adjacent to the NASA/Johnson Space Center near Houston. Salary and benefits are competitive and attractive and depend on individual qualifications. Respond before Oct. 31, 1984 to:

Director's Office, LPI
3303 NASA Road 1
Houston Texas 77058

An equal opportunity employer

Structural Geologist/Ohio State University. The Department of Geology and Mineralogy of Ohio State University invites applications for a tenure track position for a structural geologist with significant field experience in a variety of tectonic settings. The position requires a Ph.D. with emphasis in structural geology, regional tectonics or geophysics. The new faculty member will have the opportunity to teach in the area of his or her research, and will also be assigned to teach in the graduate courses. The successful candidate will be expected to establish a vigorous research program involving graduate students. The person who fills this position will have an active program in structural geology and tectonics that includes both field projects and integrated geology/geophysics and mechanical/fluid chemistry studies of structures in the western Cordillera. There is an excellent opportunity to collaborate with other faculty in structural geology, sedimentology, geophysics, geochemistry and petrology. A vita, copies of publications, names of three persons who may provide references, and a letter outlining the candidate's research and teaching interests should be sent to Dr. William P. Nairn, Chairman, Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112-1185. Deadline for receipt of applications is December 31, 1984 with the appointment starting in September 1985.

The University of Utah is an equal opportunity affirmative action employer.

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The University of Utah is an equal opportunity affirmative action employer.

DIRECTOR OF HAZARDOUS WASTE MANAGEMENT AND TWO SENIOR HYDROGEOLOGISTS

SHANNON & WILSON, INC., a leading national geotechnical and applied geoscience consulting firm with 30 years of experience, has immediate openings for a Director of Hazardous Waste Management and a senior-level Hydrogeologist in its St. Louis office and a senior-level Hydrogeologist in its Seattle office. The successful candidate will lead the company's existing well-established groundwater and hazardous waste groups. Each position will require proven business development and project management skills and national-class technical expertise.

The Director of Hazardous Waste Management will provide overall leadership of the company's Waste Management work. The successful candidate must have an advanced degree in a related field and over 15 years of direct experience in site characterization, groundwater-quality assessment, and remedial action methods.

The senior-level Hydrogeologists must have an advanced degree in geology or hydrogeology and over 10 years of direct experience in water resource development, geotechnical projects, groundwater modeling and groundwater contamination studies.

SHANNON & WILSON, INC.

Attn: Earl A. Sibley

P.O. Box C-30313

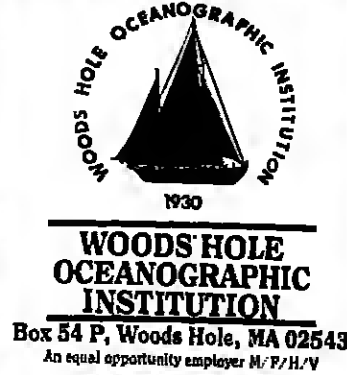
Seattle, WA 98103-8067

An Equal Opportunity Employer

DEPARTMENT CHAIRMAN

The Woods Hole Oceanographic Institution invites applicants for the position of Chairman, Department of Physical Oceanography. This position requires an appointment as Senior Scientist with tenure, in the Department. The candidate should have a record of distinguished publication in the field and the ability to raise support for research. A Chairman's own research, usually occupies approximately half-time. The remainder is devoted to teaching and departmental matters. The chief executive task of the successful candidate will be to maintain and to enhance the quality of the Department. The duration of the appointment and salary are negotiable.

Please send curriculum vitae and list of publications to Personnel Manager. Applicants are requested to respond before November 30, 1984 if possible.



Hydrogeologist/Texas A&M University. The Department of Geology and Center for Engineering Geosciences have a tenure track opening, preferably at the assistant professor level, for which the first search will be for a creative individual working in applied geological hydrology.

The successful applicant will be expected to develop teaching and research recognition at a national level. The position is available beginning September 1, 1984 and will be held open until filled. Applicants should submit a vita including names of references to M.C. Gilbreath, Department of Geology, Texas A&M University, College Station, TX 77843.

Texas A&M University is an affirmative action/equal opportunity employer.

Academic Administrator/Assistant or Associate Research Oceanographer. The Center for Coastal Studies, Scripps Institution of Oceanography has an opening for a split-position. Academic Administrator/50% Assistant/Associate Research Oceanographer.

The Center conducts a wide variety of field, laboratory and theoretical work in waves, currents, shore processes, mechanics of nearshore sediment transport, estuarine processes, continental shelf and marginal seas research.

The successful candidate will have a Ph.D. in physical oceanography or coastal sciences. The level of appointment will be determined by experience and level of independence in his/her field as evidenced by reviewed publication record in the scientific literature and successful record in the management of interaction with a variety of people within and outside the University, particularly funding agencies. Essential: Knowledge of a broad spectrum of research areas in coastal oceanography. Some understanding of administrative issues, e.g., personnel and budgets, is essential.

The Administrator portion of the position is permanently state-funded. The Research portion will be funded by the Center for 12-18 months to enable the candidate to obtain contract/grant funding either separately or in cooperation with other department researchers.

Send resumes, including list of research interest and list of publications, with three letters of reference by 31 October 1984 to:

Dr. Douglas L. Inman, Director
Center for Coastal Studies, Scripps Institution of Oceanography
University of California-San Diego
La Jolla, CA 92093

USCO is an Equal Opportunity/Affirmative Action Employer.

Experimental Physicist

The MIT Center for Space Research has a position available on the research staff for an experimental physicist with a background in space plasma physics or in a closely related field. The research program in this area involves the design, development, evaluation and construction of instruments for a variety of space missions. Direct experience in the design and construction of balloon, rocket or satellite-borne instrumentation is required. The position affords the opportunity for part-time work on the basis of a contract depending on the interests of the applicant.

Send 2 copies of resume including a list of publications to:
Dr. H.S. Bridge, c/o Personnel,
210-220, 77 Massachusetts Ave.,
Cambridge, MA 02139. Salary for this position will be commensurate with qualifications of the applicant. Refer to Job #84-868.

MIT is an equal opportunity/affirmative action employer.

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Seismologist/Ohio State University. The Department of Geology and Mineralogy, The Ohio State University, invites applications for a tenure-track position for a seismologist with research interests in crustal geology and tectonics. The successful applicant must be prepared to assist in teaching geophysics courses, advanced topics in higher geophysics, conduct research, and supervise graduate students. Postdoctoral or industrial experience is desirable. Rank and salary commensurate with education and research record. Please send applications to:

Dr. Ralph R. von Frese
Chairman, Search Committee
Department of Geology and Mineralogy
The Ohio State University
Columbus, OH 43210

Telephone: 614/292-5685 or 422-7291.
Applications should include a resume, a statement of research interests and three persons whom we may contact for recommendations. The closing date for applications is December 1, 1984; appointments will be effective no later than October 1, 1985. Additional information may be obtained by writing or calling the chairman of the search committee.

The Ohio State University is an equal opportunity/affirmative action employer.

The University of Kansas/Faculty Positions. The University of Kansas, Department of Geology, seeks to fill three tenure track positions at the Assistant Professor level to begin in Fall, 1985. The Department seeks persons committed to academic careers involving teaching, research, and service. Salaries will be determined by qualifications and experience and will be competitive. Candidates should hold the Ph.D. degree in Geological Sciences or have a near completion.

All positions carry responsibility for teaching at both undergraduate and graduate level, conducting active programs of research and publication, and supervising the research of students. Candidates should expect to teach introductory courses as well as in their specialties. The Department may give preference to those who are qualified physically and by training or experience to teach in our summer field programs and have the capability to use the computer to solve geological problems.

Position 1. Sedimentation, with interests in the interaction of sedimentary processes and stratigraphy, diagenesis and low-temperature geochemistry, or tectonics. Duties will include teaching courses in stratigraphy, sedimentation, sedimentary geochemistry, or tectonics.

Position 2. Tectonics, with interest in the interface between tectonic processes and sedimentation, igneous phenomena, or metamorphism. Duties will include teaching courses in structural geology and tectonics.

The University of Kansas is an equal opportunity/affirmative action employer.

Meetings

Announcements

Water Resources

Oct. 1-4, 1984 5th International Conference on Water Resources Planning and Management. Athens, Greece. Sponsors: European Mediterranean Commission for Water Planning, Hellenic Republic Ministry of Research and Technology. Conference Secretariat: T. Nantopoulos, Division of Water Resources, National Technical University of Athens, 5, Zografou St., CR-137 73 Zografou, Athens, Greece.

Among the topics to be covered are: undersea springs and small coastal basins; island applied hydrology; evaluating and forecasting floods and droughts; water development in arid zones; and forecasting hydrological phenomena in real time.

Thermosphere Dynamics

October 3-5, 1984 Coddard Workshop on Thermosphere Dynamics II, Calverton, Md. Sponsors: NASA Goddard Space Flight Center, (Aleta E. Johnson, Laboratory for Atmospheres, NASA Goddard Space Flight Center, Greenbelt, MD 20771.)

The meeting will assess current understanding of thermosphere dynamics and identify new directions for scientific research in that specialty. The emphasis of the workshop will be on describing the structure and dynamics of the neutral thermosphere, and data recently obtained from the Dynamics Explorer spacecraft and new measurements from ground-based facilities will be considered. Among the topics to be discussed are: thermospheric energization processes, long term variations and superrotation, gravity waves, mesosphere-thermosphere coupling, and planetary thermospheres.

Front Range Branch Yellowstone Geology

October 25, 1984 ACU Front Range Branch Symposium on Geophysics and Geology of Yellowstone, Golden, Colorado. Sponsors: AGU Front Range Branch, USGS, Cooperative Institute for Research in Environmental Sciences, U.S. Park Service, AGU Front School of Mines. (Jo Ann Jocelyn, AGU Front Range Branch, NOAA/ES&C, 815/E2, 825 Broadway, Boulder, CO 80508; tel.: 303-497-5147.)

The deadline for submission of (one paragraph) abstracts is October 19, 1984. This symposium, open free of charge to the public, will feature invited talks as well as poster sessions. Outstanding scientists in a variety of geophysical disciplines will present results of their studies in the Yellowstone area. In addition, interested parties are encouraged to submit abstracts of papers to be presented in two poster sessions. Topics will include geochemistry of trace elements within

tonics or petrology. Candidates with field orientation will be preferred.

At least three letters of recommendation should be submitted to the Search Committee, Department of Geology, University of Kansas, Lawrence, Kansas 66045-2124. Application materials must be received by 5:00 p.m. November 19, 1984. The positions are contingent upon availability of funds.

The University of Kansas is an AA/EEO employer and encourages applications from all qualified persons.

Project Associate/Specialist: Electro Micro-Probe Lab. University of Wisconsin-Madison. Strong analytical background in quantitative EAP analysis and familiarity with computers is required. The Lab has a spectrometer ARL SQUO and a JEOLC 50-A SEM. Duties will include instrument maintenance, instruction of students, development of procedures and analysis. Research will be encouraged. A MS degree in Earth Science, Chemistry, Physics or Engineering. Minimum salary will be \$18,000/12 months with an MS. Send letter of application, transcript, resume, and names and address of three references by September 15 to Dr. John W. Valley, Department of Geology & Geophysics, Weeks Hall, University of Wisconsin, Madison, WI 53706.

An equal opportunity employer.

University of Texas at Austin. The Department of Geological Sciences seeks to fill tenure track positions effective fall 1985 in one or more of the following disciplines: 1) micropaleontology; 2) paleogeography; 3) paleontology; 4) mineralogy; 5) hydrogeology; 6) sedimentology; 7) petrology; 8) geophysics; 9) tectonics; 10) structural geology; 11) paleogeography; 12) paleontology; 13) paleogeography; 14) paleontology; 15) paleogeography; 16) paleontology; 17) paleogeography; 18) paleontology; 19) paleogeography; 20) paleontology; 21) paleogeography; 22) paleontology; 23) paleogeography; 24) paleontology; 25) paleogeography; 26) paleontology; 27) paleogeography; 28) paleontology; 29) paleogeography; 30) paleontology; 31) paleogeography; 32) paleontology; 33) paleogeography; 34) paleontology; 35) paleogeography; 36) paleontology; 37) paleogeography; 38) paleontology; 39) paleogeography; 40) paleontology; 41) paleogeography; 42) paleontology; 43) paleogeography; 44) paleontology; 45) paleogeography; 46) paleontology; 47) paleogeography; 48) paleontology; 49) paleogeography; 50) paleontology; 51) paleogeography; 52) paleontology; 53) paleogeography; 54) paleontology; 55) paleogeography; 56) paleontology; 57) paleogeography; 58) paleontology; 59) paleogeography; 60) paleontology; 61) paleogeography; 62) paleontology; 63) paleogeography; 64) paleontology; 65) paleogeography; 66) paleontology; 67) paleogeography; 68) paleontology; 69) paleogeography; 70) paleontology; 71) paleogeography; 72) paleontology; 73) paleogeography; 74) paleontology; 75) paleogeography; 76) paleontology; 77) paleogeography; 78) paleontology; 79) paleogeography; 80) paleontology; 81) paleogeography; 82) paleontology; 83) paleogeography; 84) paleontology; 85) paleogeography; 86) paleontology; 87) paleogeography; 88) paleontology; 89) paleogeography; 90) paleontology; 91) paleogeography; 92) paleontology; 93) paleogeography; 94) paleontology; 95) paleogeography; 96) paleontology; 97) paleogeography; 98) paleontology; 99) paleogeography; 100) paleontology; 101) paleogeography; 102) paleontology; 103) paleogeography; 104) paleontology; 105) paleogeography; 106) paleontology; 107) paleogeography; 108) paleontology; 109) paleogeography; 110) paleontology; 111) paleogeography; 112) paleontology; 113) paleogeography; 114) paleontology; 115) paleogeography; 116) paleontology; 117) paleogeography; 118) paleontology; 119) paleogeography; 120) paleontology; 121) paleogeography; 122) paleontology; 123) paleogeography; 124) paleontology; 125) paleogeography; 126) paleontology; 127) paleogeography; 128) paleontology; 129) paleogeography; 130) paleontology; 131) paleogeography; 132) paleontology; 133) paleogeography; 134) paleontology; 135) paleogeography; 136) paleontology; 137) paleogeography; 138) paleontology; 139) paleogeography; 140) paleontology; 141) paleogeography; 142) paleontology; 143) paleogeography; 144) paleontology; 145) paleogeography; 146) paleontology; 147) paleogeography; 148) paleontology; 149) paleogeography; 150) paleontology; 151) paleogeography; 152) paleontology; 153) paleogeography; 154) paleontology; 155) paleogeography; 156) paleontology; 157) paleogeography; 158) paleontology; 159) paleogeography; 160) paleontology; 161) paleogeography; 162) paleontology; 163) paleogeography;

Meetings (cont. from p. 711)

mation, irrigation potential, and irrigation practice.

IAGA Assembly

August 5-17, 1985 5th Scientific Assembly of the International Association of Geomagnetism and Aeronomy (IAGA), Prague, Czechoslovakia. (Michael Gadsden, Natural Philosophy Dept., Aberdeen Univ., Aberdeen AB9 2UE, Scotland.)

The assembly will include a full program of scientific sessions involving all the following IAGA Divisions and Commissions together with two Commissions of the International Association of Meteorology and Atmospheric Physics (IAMAP): Solid Earth Geomagnetism; Aeronomy; Magnetosphere; Solar Wind; Observatories and Indices; Antarctic History; Middle Atmosphere; Internal/External Geomagnetism; Developing Countries; Meteorology of the Upper Atmosphere; and Radiation.

IAGA Working Group 1-5 (Paleomagnetism) has arranged for a full day session on "Analytical Methods for Paleomagnetism" on August 12. Among the possible topics for discussion are methods of generating APW paths from paleomagnetic data, methods of using APW paths to determine relative positions of plates, methods of handling temporal data such as those from sediment cores, and special problems involving archaeomagnetic data. Those who wish to present papers at this session are asked to contact C. G. A. Harrison, School of Marine and Atmospheric Science, University of Miami, 4600 Rickenbacker Cswy, Miami, FL 33119.

Future AGU Meetings

Fall Meetings

• Dec. 5-7, 1984, San Francisco, California. Abstracts due September 12, 1984; call for papers appeared in July 3, 1984 Eos.

• Dec. 9-13, 1985, San Francisco, California. Abstracts due mid-September 1985.

• Dec. 8-12, 1986, San Francisco, California.

Spring Meetings

• May 27-31, 1985, Baltimore, Maryland. Abstracts due early March 1985.

• May 19-23, 1986, Baltimore, Maryland.

Regional Meetings

• Front Range Branch Symposium on Geophysics and Geology of Yellowstone, October 25, 1984, Golden, Colorado. Abstracts due October 12, 1984; call for papers appears in September 18, 1984 Eos.

• Front Range Branch Hydrology Days, April 16-18, 1985, Fort Collins, Colorado. Abstracts due December 31, 1984 for professional hydrologists; February 15, 1985 for students; call for papers appeared in July 24, 1984 Eos.

Chapman Conferences

• Vertical Crustal Motion: Measurement and Modeling, October 23-26, 1984, Harpers Ferry, West Virginia.

• Solar Wind-Magnetosphere Coupling, February 12-15, 1985, Pasadena, California. Abstracts due November 1, 1984; call for papers appeared in July 10, 1984 Eos.

• Ion Acceleration in the Ionosphere and Magnetosphere, June 3-7, 1985, Boston, Massachusetts.

• Magnetotail Physics, October 28-31, 1985, Laurel, Maryland.

The last Geophysical Year calendar ran August 28, 1984, in Eos.

Call 800-424-2488 to receive the latest edition of AGU's Publications Catalog.

If you have a question about your AGU book or journal order, call 800-424-2488.



Housing and Registration

The 1984 Fall Meeting of the American Geophysical Union and the Winter Meeting of the American Society of Limnology and Oceanography (ASLO) will be held in San Francisco, December 3-7, at the Civic Auditorium.

San Francisco has been host to AGU's annual Fall Meeting for many years. If you have attended previous Fall Meetings, you know what a pleasant city San Francisco can be—fine restaurants, temperate December climate, and the charms of Chinatown, Ghirardelli Square, Fisherman's Wharf, Nob Hill, and North Beach. San Francisco is an elegant city, offering a rich blend of stylish hospitality and hometown amiability. By any measure, San Francisco is an ideal backdrop for this year's scientific sessions.

Registration

Everyone who attends the meeting must register. Preregistration received by November 9 saves you time and money. The fee will be refunded to you if AGU receives written notice of cancellation by November 30. Registration rates are as follows:

	Preregistration	After November 9
Member (AGU/ASLO)	\$70	\$85
Student Member (AGU)	\$30	\$45
Retired Senior Member* (AGU/ASLO)	\$30	\$45
Nonmember	\$95	\$110
Student Nonmember	\$40	\$55

*Age 65 or over and retired from full-time employment.

Registration for 1 day is available at one half the above rates, either in advance or at the meeting. Members of the American Congress on Surveying and Mapping, the American Meteorological Society, the American Society of Photogrammetry, the Canadian Geophysical Union, the European Geophysical Union, and the Union Geofisica Mexicana may register at the AGU/ASLO member rates.

If you are not a member of AGU and you register at the full nonmember meeting rate, the difference between member (or student member) registration and nonmember registration will be applied to 1985 AGU dues if a completed membership application is received at AGU by February 28, 1985.

To preregister, fill out the registration form and return it with your payment to AGU by November 9. Preregistrants should pick up their registration material at the registration desk located at the Civic Auditorium in the Main Arena. Your receipt will be included with your preregistration material. Registration hours are 7:45 A.M. to 4:30 P.M., Monday through Friday. On Sunday, December 2, registration will be held at the Cathedral Hill Hotel. You may register from 4:00 P.M. to 8:00 P.M.

Hotel Accommodations

Blocks of sleeping rooms are being held at the following hotels:

• Cathedral Hill Hotel (\$51 single/\$55 double)
Free parking to registered guests
Limited shuttle service to and from the Civic Auditorium
Airport shuttle service available

Coffee shop opens 6:30 A.M.
• Holiday Inn Golden Gateway (\$49 single/\$55 double)

Free parking to registered guests
Limited shuttle service to and from the Civic Auditorium
Airport shuttle service available
Coffee shop opens 6:30 A.M.

• The Grosvenor Inn (\$49 single/\$55 double)
Limited shuttle service to and from the Civic Auditorium
Airport shuttle service available
Coffee shop opens 6:30 A.M.

• The Holiday Inn Civic Center (\$49 single/\$55 double)
Two blocks away from the Civic Auditorium
Free parking to registered guests
Airport shuttle service available
Coffee shop opens 6:30 A.M.

• The San Francisco Hotel (\$50 single/\$56 double)
One block away from the Civic Auditorium
Free parking to registered guests
Airport shuttle service available
Coffee shop opens 6:30 A.M.

• Carriage Inn Hotel (\$52 single/\$54 double)
Victorian style inn
Free parking to registered guests
Walking distance to the Civic Auditorium
Shuttle service available to airport
Free continental breakfast and newspaper

• Americana Hotel (\$49 single/\$54 double)
Free parking to registered guests
Walking distance to the Civic Auditorium
Shuttle service available to airport
Free coffee served in sleeping rooms

• Flamingo Motor Inn (\$43 single/\$43 double)
Free parking to registered guests
Walking distance to the Civic Auditorium
Shuttle service available to airport

• Hotel Britton (\$35 single/\$38 double)
Inexpensive parking available to registered guests
Walking distance to the Civic Auditorium
Coffee shop opens 7:00 A.M.
Shared bath
The Cathedral Hill, Holiday Inn Golden

Gateway, and the Grosvenor hotels are approximately a mile away from the Civic Auditorium. Limited shuttle bus service will be provided from these hotels to the Civic Auditorium for those who do not want to walk.

Read the housing application and mail the completed application form to the housing bureau early to ensure reservations at your preferred hotel. Reservation forms must be sent directly to the Housing Coordinator, AGU Fall Meeting, San Francisco Housing Bureau, P.O. Box 5612, San Francisco, CA 94101. Do not send housing reservation forms to the hotel.

Reservations must be received by October 31 to be confirmed. Do not write or call AGU for room reservations.

Scientific Sessions

The program summary will be published in the October 16 issue of Eos. The preliminary program with the abstracts will be published in the November 6 issue of Eos. The final meeting program, with presentation times, will be distributed at the meeting. All scientific sessions will be held at the Civic Auditorium.

Exhibits

Exhibits of instrumentation equipment, book publishers, program of government agencies, and other exhibits will be located at

the Civic Auditorium in the Main Arena. The exhibits will be open Tuesday, December 4, through Thursday, December 6, 9:00 A.M. to 5:00 P.M. daily.

The following exhibitors are confirmed to date:

Academic Press
American Congress on Surveying and Mapping
American Society of Limnology and Oceanography
Earth Data Limited
Elsevier Science Publishing Company, Inc.
Jet Propulsion Laboratory/TOPEX Project Kinematics, Inc.
Kluwer Academic Publishers (D. Reidel)
National Science Foundation
Nature's Own
Pacific Delight
Qualimetrics, Inc./Weathertronics
Schonsted Instrument Company
Sea-Bird Electronics, Inc.
Sprengnether Instruments
Springer-Verlag, New York Office
Teledyne Geotech
Terra Technology Corporation
U.S. Geological Survey

Social Functions

All meeting participants are invited to attend these events:

• Icebreaker party
Monday, 6:00-7:30 P.M.

Holiday Inn Golden Gateway
• Wine Reception
Thursday, 6:00-7:30 P.M.
Cathedral Hill Hotel
• Complimentary refreshments will be served daily at the Civic Auditorium

Business Meetings and Section Luncheons

The AGU Council will meet Tuesday, December 4, at 5:30 P.M., at the Cathedral Hill Hotel. Members are welcome to attend.

ASLO will hold a no-host smoker lunch bar, Tuesday, December 4, at 5:30 P.M., at the Cathedral Hill Hotel.

The section luncheons will be held at the San Francisco (SF) and Holiday Inn-Civic Center (HICC) hotels. Please indicate on the registration form which luncheon you plan to attend and include payment.

Do you know a colleague who would like to join AGU? Call 800-424-2488 and request membership applications.

AGU Council Meeting
Tuesday, December 4, 5:30 P.M.
Cathedral Hill Hotel

ASLO No-Host Smoker
Tuesday, December 4, 5:30 P.M.
Cathedral Hill Hotel

Tuesday, December 4, Noon
Geomagnetism and Paleomagnetism (HICC), \$11.50

Planetology/Volcanology, Geochemistry, and Petrology (SF), \$11.50

Seismology (SF), \$7.50. Speaker: William L. Ellsworth, USGS; Topic: "We Are Closer Than You Think to Earthquake Prediction"

Wednesday, December 5, Noon
Geodesy (SF), \$11.50

Ocean Sciences/ASLO (SF), \$11.50. Speaker: Dr. John Imbrie, Brown University; Topic: "Climate and Biotic Response to Long-Term Changes in the Earth's Orbit"

Solar Planetary Relationships (HICC), \$11.50. Speaker: Frederick L. Scarf, TRW; Topic: "Solar-Planetary Programs 1985-2015: A Plan for New Ideas"

Thursday, December 6, Noon
Atmospheric Sciences (SF), \$11.50

Hydrology (HICC), \$11.50

Tectonophysics (SF), \$11.50. Speaker: Dr. Barry Raleigh, Director, L-DGO

American Geophysical Union 1984 FALL MEETING ASLO WINTER MEETING

HOUSING REGISTRATION FORM

READ CAREFULLY and RETURN FORM DIRECTLY TO THE SAN FRANCISCO HOUSING BUREAU AT THE FOLLOWING ADDRESS:

Housing Coordinator
AGU Fall Meeting
SF Housing Bureau
P.O. Box 5612
San Francisco, CA 94101

Please print or type all information, abbreviating as necessary. Confirmation will be sent by the hotel to the individual named in Part I. If more than one room is required, this form may be photocopied.

Part I

REQUESTOR

Last Name _____ First _____

Name of Company or Firm _____

Street Address or P.O. Box Number _____

City _____ State/Prov. _____ Zip U.S.A. _____

Country _____ Telephone Number _____

Part II

INSTRUCTIONS: Select FOUR Hotels of your choice from the list of participating facilities, then enter the name on the lines below.

First Choice _____ Second Choice _____ Third Choice _____ Fourth Choice _____

NOTE: Rooms are assigned on a "First Come, First Served" order, and if none of your choices are available, another facility will be assigned based on a referral system. A cut-off date is in effect: your application may not be processed if received after 14 days prior to your arrival date. AGU housing registration deadline is October 31.

Part III

INSTRUCTIONS: 1. Select type of room desired with arrival and departure dates.
2. PRINT or TYPE names of ALL persons occupying room.
3. If more than two persons share a room, check twin and the hotel will assign two double beds.

CHECK ONE

☐ SINGLE (Room with one bed one person)
☐ DOUBLE (Room with one bed two persons)
☐ TWIN (Room with two beds one person)

Arrival Date _____

Arrival Time _____ AM/PM

Departure Time _____

Guest Names (Last name first)

1. _____

2. _____

3. _____

4. _____

IMPORTANT NOTE: Hotel MAY require a deposit or some other form of guaranteed arrival. If so, instructions will be on your confirmation form.



HOTEL ACCOMMODATIONS PARTICIPATING HOTELS

Cathedral Hill Hotel
(\$51 Single/\$55 Double)
Van Ness at Geary
(800) 227-4730

Holiday Inn Golden Gateway
(\$49 Single/\$55 Double)
1500 Van Ness Avenue
(415) 441-4000

Grosvenor Inn
(\$49 Single/\$55 Double)
Van Ness at Geary
(415) 673-7411

Holiday Inn Civic Center
(\$49 Single/\$55 Double)
50 8th Street
(415) 625-6103

San Francisco Hotel
(\$50 Single/\$56 Double)
1231 Market Street
(415) 625-8000

All hotel reservations must be made on the housing form by October 31, 1984. No telephone request will be accepted. Confirmations will be mailed directly to registrants by the individual hotels. A first night's deposit may be required by the hotel to guarantee your room. Changes and cancellations should be made directly to the hotel.

Mail your completed housing form directly to:

Housing Coordinator
AGU Fall Meeting
San Francisco Housing Bureau
P.O. Box 5612
San Francisco, CA 94101

AGU 1984 Fall Meeting DECEMBER 3-7 San Francisco, California ASLO WINTER MEETING

REGISTRATION FORM

Deadline for Receipt of
Preregistration
November 9, 1984

(rates applicable only if received by November 9 with payment)

	More than one day	One day
MEMBER	<input type="checkbox"/> \$70 <input type="checkbox"/> \$85	<input type="checkbox"/> \$35
STUDENT MEMBER	<input type="checkbox"/> \$30 <input type="checkbox"/> \$45	<input type="checkbox"/> \$15
*RETIRED SENIOR MEMBER	<input type="checkbox"/> \$30 <input type="checkbox"/> \$45	<input type="checkbox"/> \$15
NONMEMBER	<input type="checkbox"/> \$95 <input type="checkbox"/> \$110	<input type="checkbox"/> \$47.50
STUDENT NONMEMBER	<input type="checkbox"/> \$40 <input type="checkbox"/> \$55	<input type="checkbox"/> \$20

*Age 65 or over and retired from full-time employment

SECTION LUNCHEONS

Circle section and indicate number of tickets. All lunches begin at noon.

_____ Geomagnetism and Paleomagnetism, Tuesday, \$11.50
_____ Planetology/Volcanology, Geochemistry and Petrology, Tuesday, \$11.50
_____ Seismology, Tuesday, \$7.50
_____ Geodesy, Wednesday, \$11.50
_____ Ocean Sciences/ASLO, Wednesday, \$11.50
_____ Solar-Planetary Relationships, Wednesday, \$11.50
_____ Atmospheric Sciences, Thursday, \$11.50
_____ Hydrology, Thursday, \$11.50
_____ Tectonophysics, Thursday, \$11.50

Total Enclosed \$ _____
(All orders must be accompanied by payment or credit card information. Make check payable to AGU.)

☐ American Express
Charge to: ☐ Visa ☐ MasterCard

Gard Number _____

Master Card Interbank No. _____

Expiration Date _____

Signature _____

Code _____
Check No. _____

RETURN THIS FORM WITH PAYMENT TO:

Meeting Registration
American Geophysical Union
2000 Florida Avenue, N.W.
Washington, D.C. 20009

Or Call: Toll free 800-424-2488

or
Meetings 202-462-6903

PLEASE PRINT CLEARLY

NAME ON BADGE _____

AFFILIATION (for badge) _____

MAILING ADDRESS _____

TELEPHONE # _____
HOTEL _____

Days you plan to attend

Please check the appropriate box(es)

☐ Mon ☐ Tues ☐ Wed ☐ Thur ☐ Fri

Please check appropriate box.

Members of ASLO and the cooperating societies may register at AGU member rates

☐ Member AGU ☐ Member ASLO

Member cooperating society

☐ AMS-American Meteorological Society
☐ ASP-American Society of Photogrammetry
☐ ACSM-American Congress on Surveying and Mapping
☐ EGU-European Geophysical Union
☐ UGM-Union Geofisica Mexicana
☐ CGU-Canadian Geophysical Union

Nonmembers

If you register at the full-meeting nonmember rate, the difference between member (or student member) registration and nonmember registration will be applied to AGU dues if a completed membership application is received at AGU by February 28, 1985.

Preregistrants

Your receipt will be in your preregistration packet. The registration fee will be refunded if written notice of cancellation is received in the AGU office by November 30. The program and meeting abstracts will appear in the November 6 issue of Eos.

